Application: Design a microfluidic device for a drug delivery experiment

This is a team assignment; every member of your team must take part in doing this assignment. Only one member of your team needs to submit this form.

Once you submit this form, please email a schematic diagram of your designed microfluidic device to realavi@mit.edu. The diagram can be hand-drawn or digital.

The challenge

Imagine you are an applied researcher at a pharmaceutical company, working on the development of a new antibiotic drug (chemical) for treating an infectious disease caused by bacteria.

Initial testing of the chemical seems promising, and you are now at the stage of drug development where you need to determine the optimal amount of the chemical in terms of effectiveness and toxicity for the most common patient profile, in preparation for clinical trials. To do this, you will need to run a drug delivery experiment by monitoring cultured (living and growing) cells as they are exposed to varying concentrations of the chemical.

To achieve this benefit, you will need to design a microfluidic device (system of interest) containing the pathogenic (disease-causing) bacteria, with the following function:

Input: two concentrations: 0% (buffer) and 100% (all chemical), from one or more input systems. In this particular case, an input system is a syringe. You may use unlimited amounts of either concentration.

Output: ten different concentrations of the chemical, ranging from *medium* (50% chemical, 50% water) to 100% chemical, delivered to an output system. In this particular case, the output system is a reservoir.

Select the simplest and most efficient design required to achieve the intended function of the system. You can use any part and any number of parts. The parts you can use are inlets, outlets, channels, mixers, valves, and membranes.

You can use the [Preparation article on systems thinking]() as a source for the systems thinking framework (SAFO).

Parts and their behaviors

Inlet: transports the solution toward a channel or a mixer.

Outlet: transports the solution toward the waste/reservoirs or for recollection of fluid for chemical analysis.

Channel: transports the solution inside the device. For purposes of this assignment, we assume that the input concentrations reach a linear gradient in the channel and do not mix completely.

Mixer: generates a new concentration of chemical in the solution from multiple inputs of different concentrations. A mixer can be connected to inlet/s and/or channel/s. The concentration at the exit point of the mixer is an average of the input concentrations. For example, two inputs with low and high concentration, respectively, will result in a medium concentration at the exit point of the mixer.

Valve: blocks or releases the flow of the solution through different parts of a microfluidic device, usually inlet/s or outlet/s. For purposes of this assignment, assume you can control the valves as you like.

Membrane: Used to filter molecules within the solution by size.

* Indicates required question

Email *

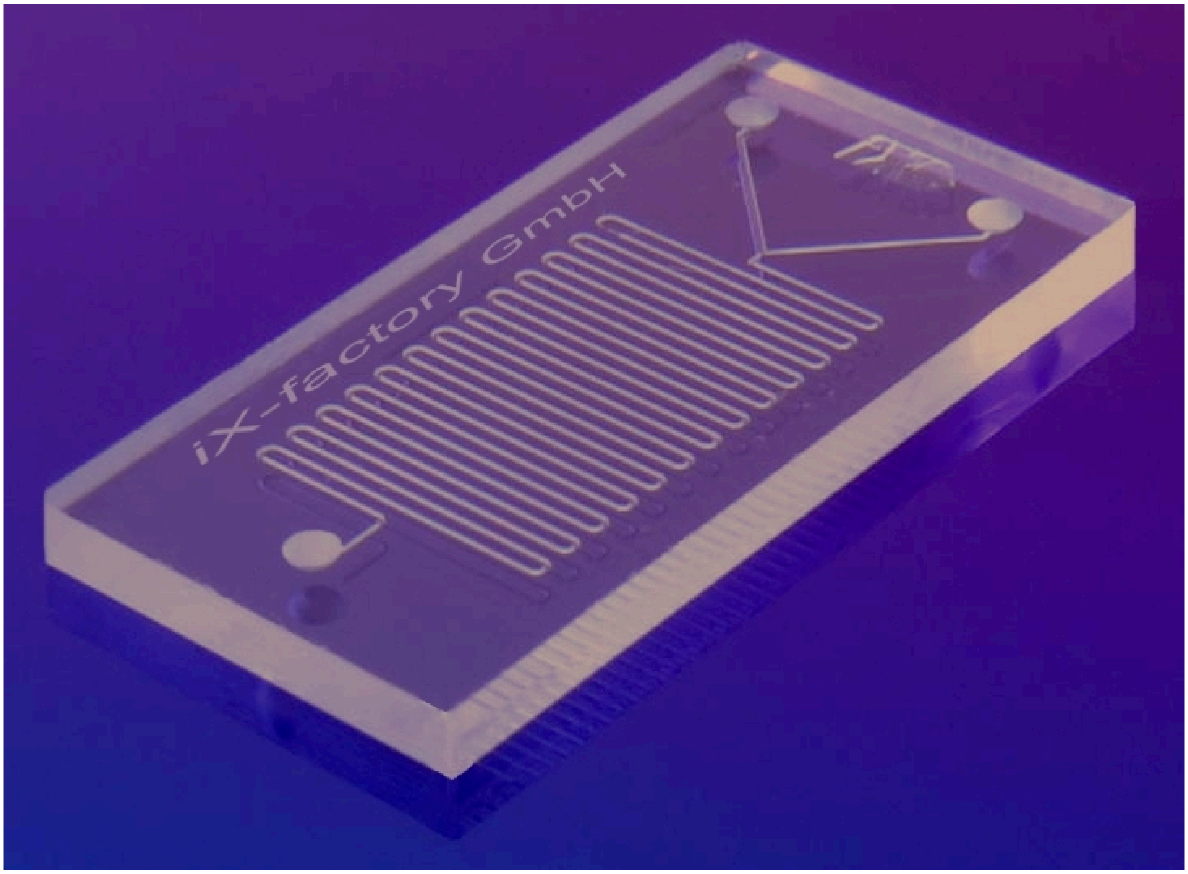
Your email

Select your team's letter. *

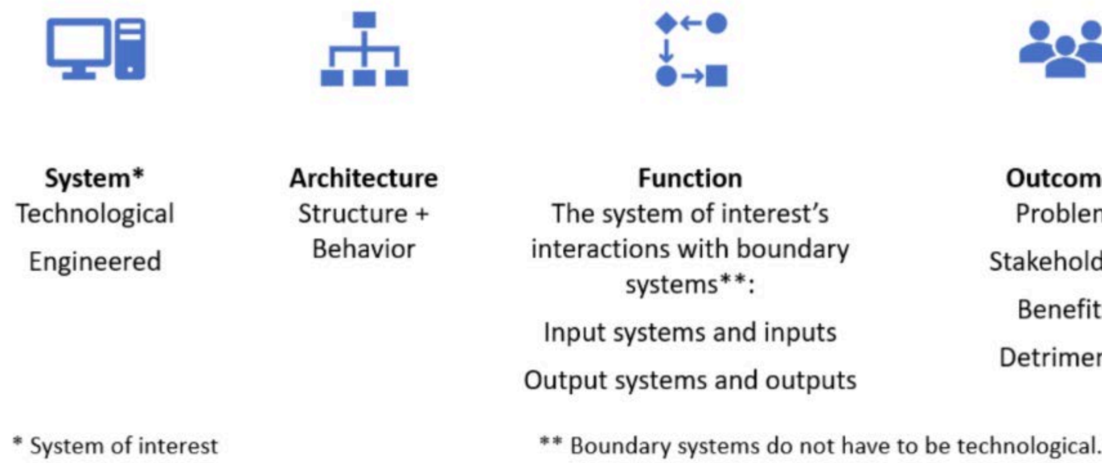
- A
- B
- C
- D

Microfluidic chip fabricated in glass.

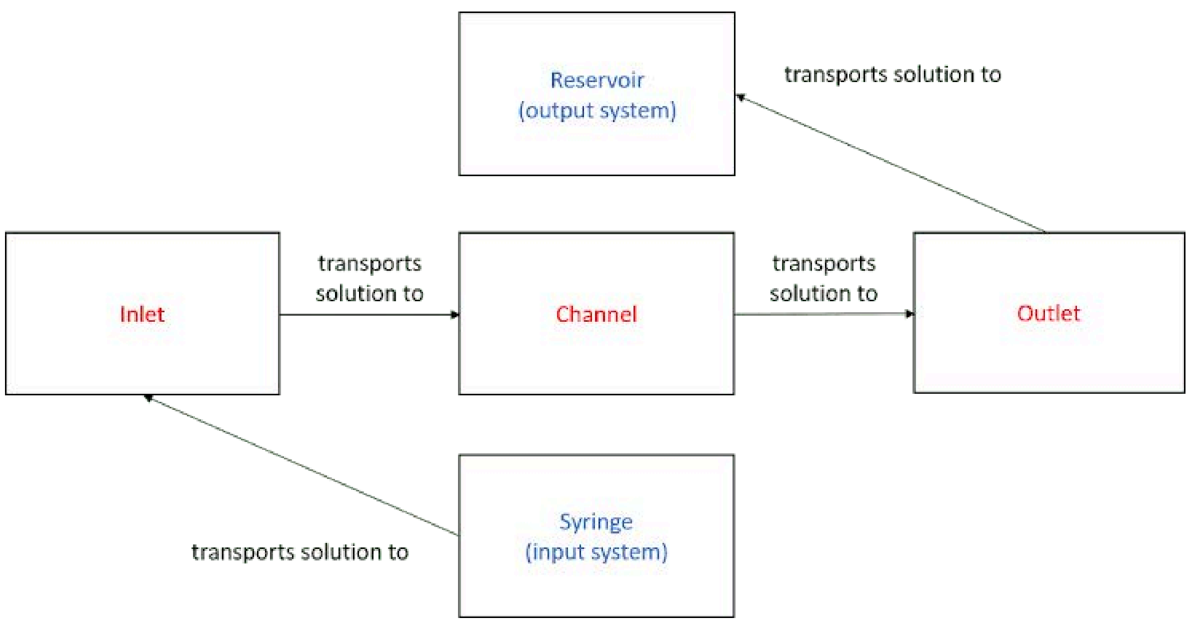
This chip contains two inlets, multiple channels (or one long, winding channel), and one outlet. Each channel is 50μm deep and 150μm wide.



System Architecture-Function-Outcome (SAFO) framework



Schematic of the system architecture and function of a basic microfluidic device for this particular case, containing one inlet, one channel, and one outlet.



Select parts (system structure) for achieving the intended function of the system of interest (the microfluidic device). *

- [ ] Valve/s
- [ ] Mixer/s
- [ ] Membrane/s
- [ ] Channel/s
- [ ] Inlet/s
- [ ] Outlet/s

For each part you selected, mention the number of parts and describe their behavior (interactions with the other parts). *

Your answer

Explain how your designed architecture will help achieve the intended function of the system of interest. *

Your answer

A copy of your responses will be emailed to the address you provided.

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